

Claims

Claim 1. Apparatus for diminishing the concentration of ammonium in waste-water, and for disposing of the ammonium as nitrogen gas, wherein:

[02] the apparatus includes an ammonium-extraction-and-transfer station, which:-

[03] - includes a waste-water entry port, for receiving a stream of the waste-water to be treated;

[04] - is operable to extract ammonium out of solution from the waste-water stream;

[05] - includes a treated-water discharge port, for discharging the waste-water stream, now with its dissolved ammonium content reduced, from the apparatus;

[06] the apparatus includes a body of secondary-water;

[07] the apparatus includes a secondary-water circuit, comprising water-containment components, which contain the body of secondary-water;

[08] the ammonium-extraction-and-transfer station is operable to transfer the ammonium extracted from the stream of waste-water into solution in the body of secondary water;

[09] the apparatus includes an electrolysis station;

[10] the secondary-water circuit is operable to convey the secondary-water between the ammonium-transfer station and the electrolysis station;

[11] the electrolysis station includes an electrolytic cell, which is operable upon being supplied with electrical energy:-

[12] - to electrolyse the secondary-water, and to oxidise the ammonium dissolved therein;

[13] - to thermodynamically favour the transformation of the nitrogen component thereof to nitrogen gas;

[14] the apparatus includes a nitrogen-discharge port, for discharging the resulting nitrogen gas from the electrolysis station.

Claim 2. Apparatus of claim 1, wherein the stream of waste-water being treated passes through the apparatus, and is discharged, without itself being subjected to electrolysis.

Claim 3. Apparatus of claim 1, wherein the stream of waste-water being treated passes through the apparatus, and is discharged, without touching the body of secondary-water.

Claim 4. Apparatus of claim 1, wherein the apparatus is operable to recirculate the body of secondary-water through and between the ammonium-extraction-and-transfer station and the electrolysis station.

Claim 5. Apparatus of claim 4, wherein the apparatus is operable to perform electrolysis on the body of secondary-water in the electrolysis station, at the same time.

Claim 6. Apparatus of claim 5, wherein the apparatus is operable to perform the electrolysis periodically, while the body of secondary-water is recirculating through the ammonium-extraction-and-transfer station.

Claim 7. Apparatus of claim 1, wherein the ammonium-extraction-and-transfer station comprises an ion-exchange station, and wherein:

[02] the ammonium-extraction-and-transfer station includes a sorbent-container, in which is contained a sorbent-body, which is effective to sorb ammonium from water passing therethrough;

[03] the secondary-water comprises regenerant-water, being water that contains, in solution, a regenerant-substance, which is of such nature, and of such concentration, as to have an ion-exchange relationship with respect to ammonium ions sorbed onto the sorbent-body;

[04] the ammonium-extraction-and-transfer station includes connecting conduits and operable flow valves;

[05] the valves are operable in a sorption-mode, and in a regenerant-mode;

[06] in the sorption-mode, the valves are arranged so that waste-water passes from the waste-water entry port, through the sorbent-container, and out of the treated-water discharge port;

[07] in the regenerant-mode, the valves are included in the secondary-water circuit, in which the regenerant-water, having passed through the sorbent-container, passes then through the electrolytic cell.

Claim 8. Apparatus of claim 7, wherein the secondary-water circuit is operable to recirculate the regenerant-water through the sorbent-container and the electrolytic cell.

Claim 9. Apparatus of claim 1, wherein:-

[02] the body of secondary-water comprises a body of acid-water;

[03] the ammonium-extraction-and-transfer station comprises an alkali-acid station,

including:-

- [04] - a means for elevating the pH of ammonium-laden waste-water entering the waste-water entry port to at least ten;
- [05] - an alkali-station, comprising a waste-water conduit containing the alkaline waste-water and a gas conduit, and the alkali-station is so structured that ammonia gas emanating from the alkaline waste-water in the waste-water conduit is captured and carried away in the gas conduit;
- [06] - a means for maintaining the pH of the acid-water at no more than four;
- [07] - an acid-station, which includes the gas conduit and an acid-water conduit containing the acid-water, and the acid-station is so structured that ammonia gas contained in the gas conduit is taken into solution in the acid-water in the acid-water conduit;
- [08] and the secondary-water circuit includes the acid-water conduit, in which the acid-water, having passed through the acid-station, passes then through the electrolytic cell.

Claim 10. Apparatus of claim 9, wherein the secondary-water circuit is operable to recirculate the acid-water through the acid-station and the electrolytic cell.

Claim 11. Water treatment plant, for treating both a lower-flowrate stream of higher-concentration waste-water and a higher-flowrate stream of lower-concentration waste-water, wherein:

- [02] the plant is operable to pass the lower-concentration stream through the ion-exchange apparatus of claim 7, and the higher-concentration stream through the alkali-acid apparatus of claim 9;
- [03] and the plant is operable to mix the treated waste-water effluent from the alkali-acid apparatus with the waste-water stream entering and passing through the ion-exchange apparatus.

Claim 12. Procedure for diminishing the concentration of ammonium in waste-water, and for disposing of the ammonium as nitrogen gas, including:

- [02] passing a stream of the waste-water to be treated in through a waste-water entry port, through an ammonium-extraction-and-transfer station, and out through a treated-water discharge port;
- [03] operating the ammonium-extraction-and-transfer station to extract ammonium out of solution from the waste-water stream;

- [04] passing a body of secondary-water around a secondary-water circuit, comprising water-containment components, which contain the body of secondary-water;
- [05] operating the ammonium-extraction-and-transfer station to transfer the ammonium extracted from the stream of waste-water into solution in the body of secondary water;
- [06] passing the secondary-water circuit between the ammonium-transfer station and an electrolysis station, containing an electrolytic cell;
- [08] supplying electrical energy to the electrolysis station and operating same to electrolyse the secondary-water, and to oxidise the ammonium dissolved therein, and to thermodynamically favour the transformation of the nitrogen component thereof to nitrogen gas;
- [09] discharging the resulting nitrogen gas from the electrolysis station.